GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT INITIATION

Date June 8, 1966

Project Title: A Multifunctional Protection System for Re-entry Vehicles

Project No.: A-947

Project Director: N. J. Corbett

Sponsor: Dept. of the Army, U. S. Army Missile Command

Effective: 6-15-66 Estimated to run until: 6-14-67

Type agreement: Contract No. DA-01-021-AMC-15260(Z)

Amount: $42,750

Reports: Monthly Status Reports
Final Technical Report

Contact Person: Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attn: AMSMI-IWC

Assigned to High Temperature Materials Branch
Chemical Sciences & Materials Division

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GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT TERMINATION

Date May 23, 1968

PROJECT TITLE: A Multifunctional Protection System for Re-entry Vehicles

PROJECT NO: A-947

PROJECT DIRECTOR: Steve H. Bomar

SPONSOR: Dept. of the Army, U. S. Army Missile Command

TERMINATION EFFECTIVE: March 20, 1968

CHARGES SHOULD CLEAR ACCOUNTING BY: May 31, 1968

All charges in excess of contract amount to be transfered to Division Account prior to June 30, 1968

High Temperature & Materials Division

REPORTS
300.A-947

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Thermochemical calculations have been performed to determine probable reactions between potential compositing materials and silica. These results, along with other pertinent physical data, were used to select the compositions of the initial specimens to be fabricated. The selections were made in consultation with personnel of the U. S. Army Missile Command.

During the coming report period the effect of the selected additives on the devitrification rate of slip-cast fused silica will be determined, and the fabrication of specimens will be undertaken. A special technical memo, containing the specific compositions of the composite specimens and carrying an appropriate security classification, will be transmitted during the next report period.

A milestone/cost accomplishment chart is appended to this report, and similar up-dated charts will accompany all future letter reports.

Respectfully submitted,

W. J. Corbett
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw
Encl.

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

August 29, 1966

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 2, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 July to 15 August 1966

Gentlemen:

During the past month the determinations of the properties of slip-cast fused silica, sintered in an argon atmosphere, have been completed. The studies were then extended to determine what effect the potential compositing materials would have on the devitrification rate when the composites were sintered in an argon atmosphere. These latter studies are necessary for determining optimum sintering times for the composites to be prepared.

A satisfactory technique for preparing the disc-shaped composite specimens has been developed. The apparatus for accomplishing the one-dimensional casting of the specimens was described in Monthly Letter Report No. 1.

Fabrication of specimens of Composite A and Composite B[1] has begun. At least three specimens of each of these composites will be delivered during the next month. Fabrication of specimens of Composites C and D will begin during the next report period.

An up-dated milestone/cost accomplishment chart is appended.

Respectfully submitted,

W. V. Corbett
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

[1] Complete descriptions of the composition and structure of Composites A through D are given in Special Technical Memo No. 1, Project A-947 (SRD).

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

October 11, 1966

Headquarters
U.S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 3, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 August to 15 September 1966

Gentlemen:

During the period covered by this report, the effort on this program was concerned with the fabrication of deliverable samples. Three samples each of Composites A, B, and D have been prepared and will be transmitted in the very near future.

At the present time, the effort is being directed toward producing three deliverable samples of Composite C. These composites fall under the category of advanced composites, because their fabrication requires the development of techniques not utilized in the fabrication of Composites A, B, and D. However, it presently appears that samples of Composite C will be ready for delivery by 1 November 1966.

An up-dated milestone/cost accomplishment chart is appended.

Respectfully submitted.

W. J. Corbett
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw
Encl.

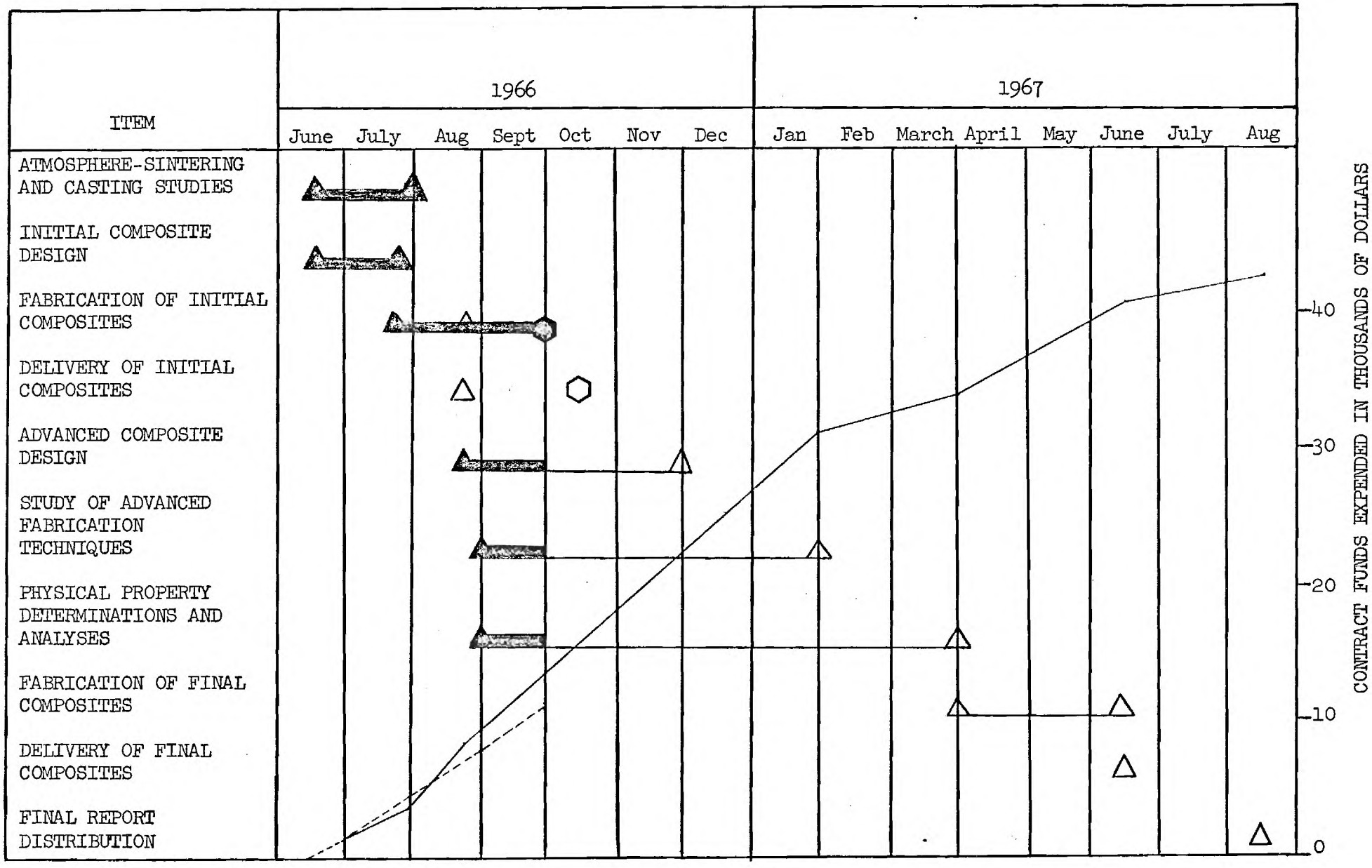
MILESTONE/COST ACCOMPLISHMENT CHART

CONTRACTOR'S NAME Georgia Tech Research Institute

Contract DA-01-021-AMC-15260(Z)

——— Projected Expenditure

- - - - Actual Expenditure



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GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

November 2, 1966

Headquarters
U.S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 4, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 September to 15 October 1966

Gentlemen:

During the period covered by this report, the effort on this program was principally concerned with the fabrication of samples of Composite C and a new composite, designated E. Three specimens of each of these composites were prepared and transmitted.

The description of Composite E, and a necessary modification that was made in the composition of Composite D, are being transmitted in a special technical memo. This memo will carry the appropriate security classification.

Also during this report period, a microstructural examination of Composites A and B have been conducted. The microstructure of Composite B was exactly as designed. However, an examination of Composite A revealed that the microstructure was not according to design. Therefore, further effort will be directed toward producing specimens of this composite with the intended microstructure.

As requested, additional samples of Composites A, B, and D (one each) will be fabricated and transmitted at the earliest possible date. Also during the coming report period, an effort will be initiated toward obtaining dielectric property measurements on the compositions studied to date.

Respectfully submitted,

W. J. Corbett
Project Director

Approved:

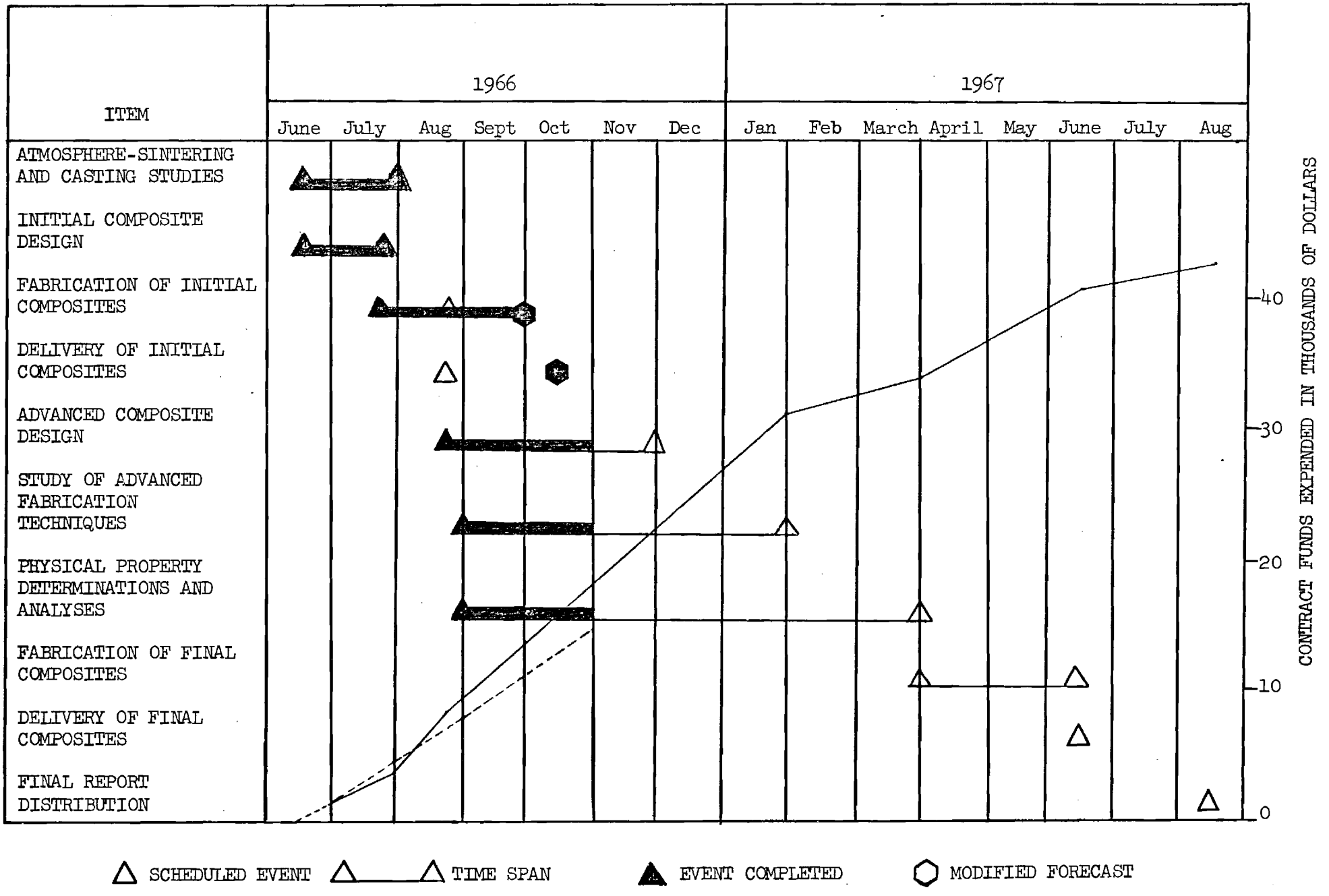
J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw

MILESTONE/COST ACCOMPLISHMENT CHART

CONTRACTOR'S NAME Georgia Tech Research Institute

Contract DA-01-021-AMC-15260(Z)



GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332
December 1, 1966

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 5, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 October to 15 November 1966

Gentlemen:

During the period covered by this report additional samples of Composites A, B, and D (one each) have been fabricated and transmitted. Also, specimens of Composite A were transmitted to replace the specimens originally transmitted. A microstructural examination of specimens similar to those originally transmitted indicated that the microstructure was not according to design. Examinations of samples similar to the latest specimens transmitted have indicated that the design microstructure has been achieved.

Efforts are underway on determinations of the dielectric properties of the compositions studied to date. Additional microstructure and physical properties investigations are being conducted on these compositions. Studies of methods to produce advanced composites with improved microstructures have been initiated.

Respectfully submitted,

W. J. Corbett
Project Director

Approved:

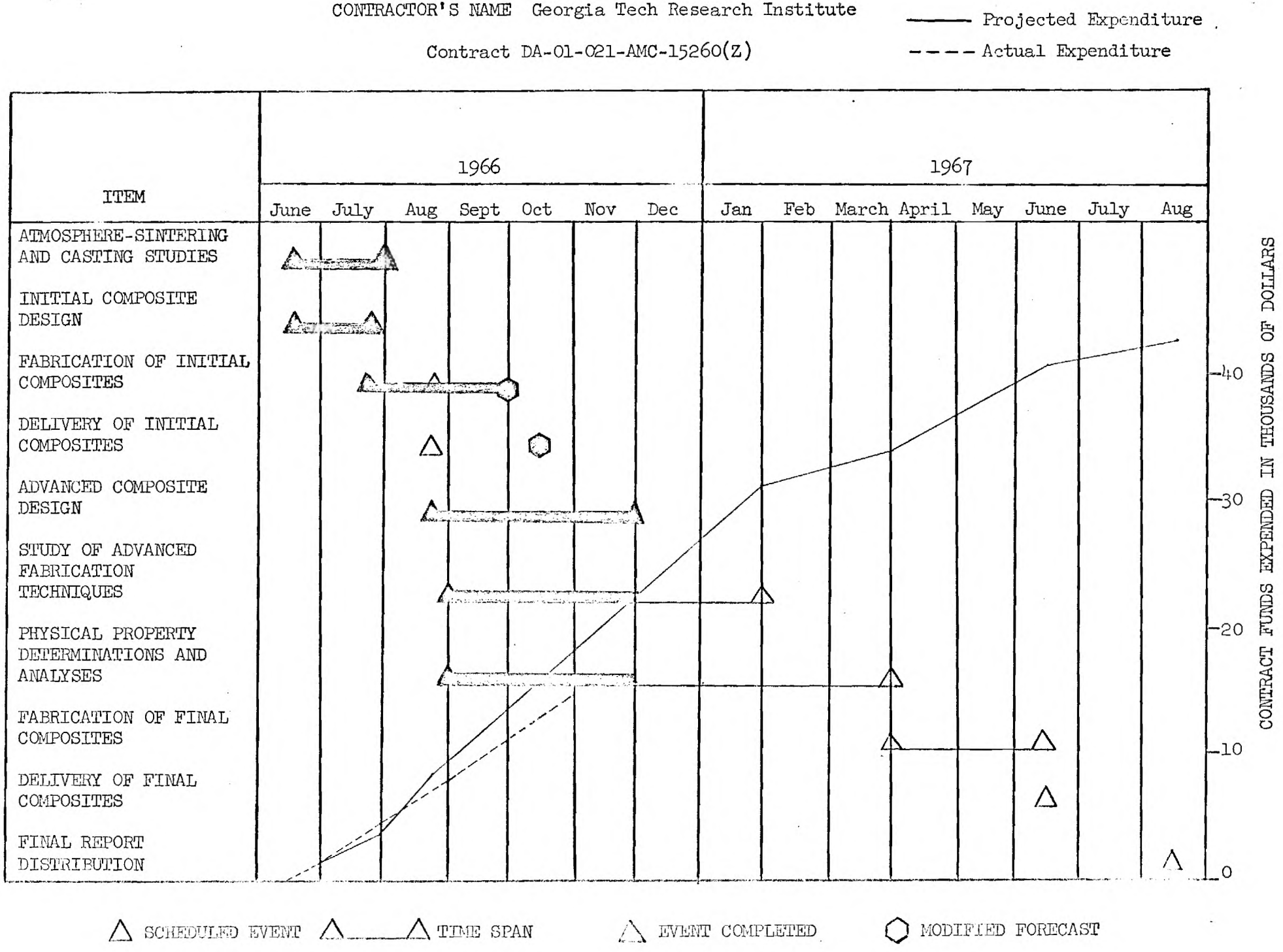
/J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw
Encl.

MILESTONE/COST ACCOMPLISHMENT CHART

CONTRACTOR'S NAME Georgia Tech Research Institute

Contract DA-01-021-AMC-15260(Z)



GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

January 5, 1967

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 6, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 November to 15 December 1966

Gentlemen:

During this report period the microstructure of Composite D has been carefully examined. Preliminary tests conducted by the U. S. Army Missile Command on specimens of Composite D indicated that its performance was not entirely satisfactory. The evidence pointed to inadequate dispersion of the included material in this composite. The results of the microstructural examination of specimens of this composite have confirmed that the dispersion was inadequate. The fabrication technique for this composite is being modified to eliminate this condition, and improved specimens are being prepared.

A delay in obtaining materials from a vendor has temporarily reduced the effort on characterization of physical properties of the composites. However, investigations of potential encapsulation materials and techniques for increasing the porosity of the composites is proceeding.

Respectfully submitted,

W. J. Corbett
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw
Encl.

MILESTONE/COST ACCOMPLISHMENT CHART

CONTRACTOR'S NAME Georgia Tech Research Institute

Contract DA-01-021-AMC-15260(Z)

——— Projected Expenditure

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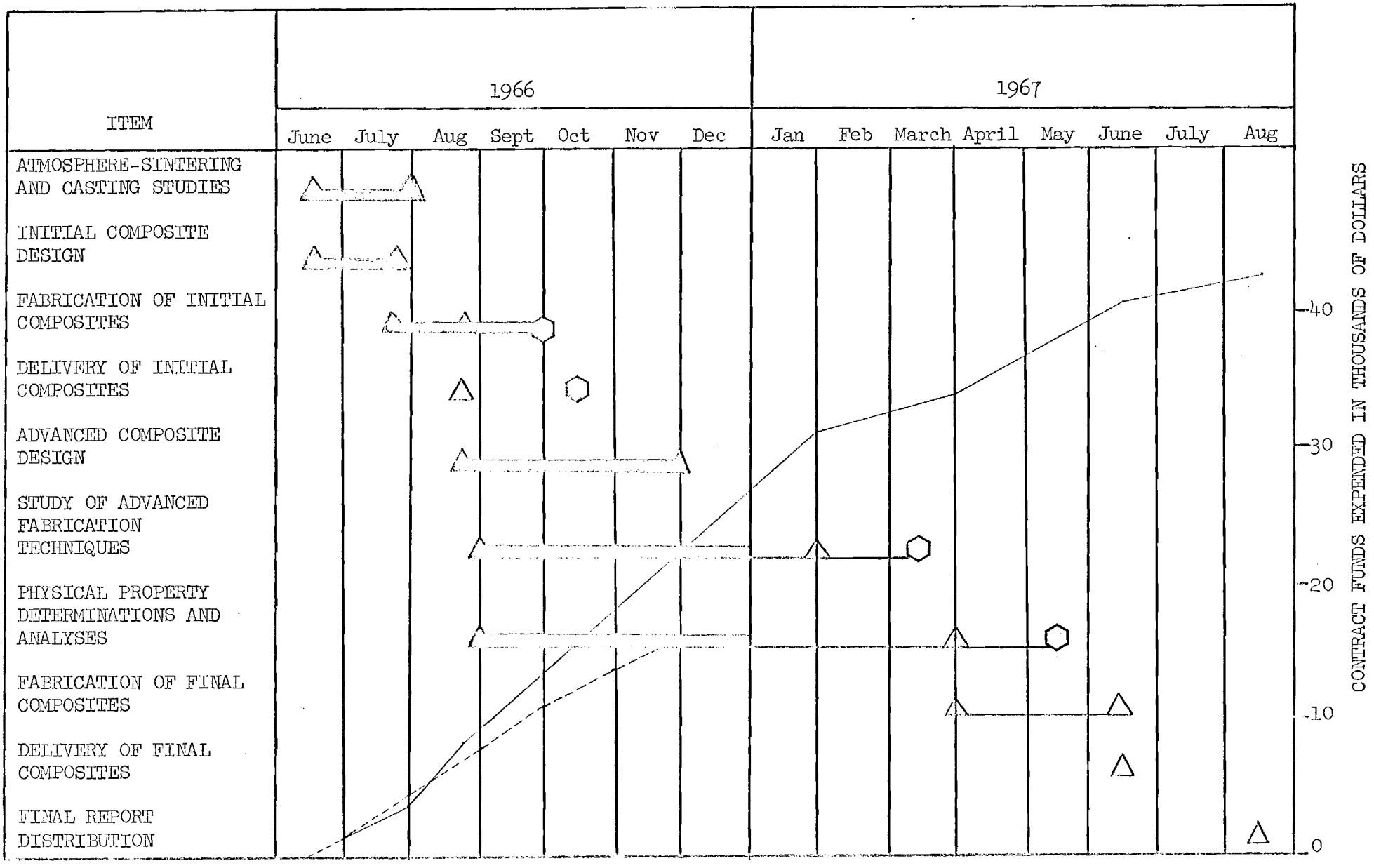

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A-947

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

February 9, 1967

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 7, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 December 1966 to 15 January 1967

Gentlemen:

During this report period specimens of Composite D have been prepared using techniques designed to improve the microstructure of this composite. A microstructural examination of a typical specimen is presently underway to determine if the desired improvement has been achieved. If the results of this examination confirm that the desired microstructure has been obtained, specimens of this composite will be transmitted during the coming month.

Results of the initial determinations of the dielectric properties of Composites B and D have been obtained. These results confirm that the technique employed can provide useful information on the dielectric properties of the composites being considered in this program. Therefore, the studies of dielectric properties will be expanded to include all the compositions under consideration.

The determination of physical properties for the composites is progressing.

Respectfully submitted,

W. J. Corbett
Project Director

Approved:

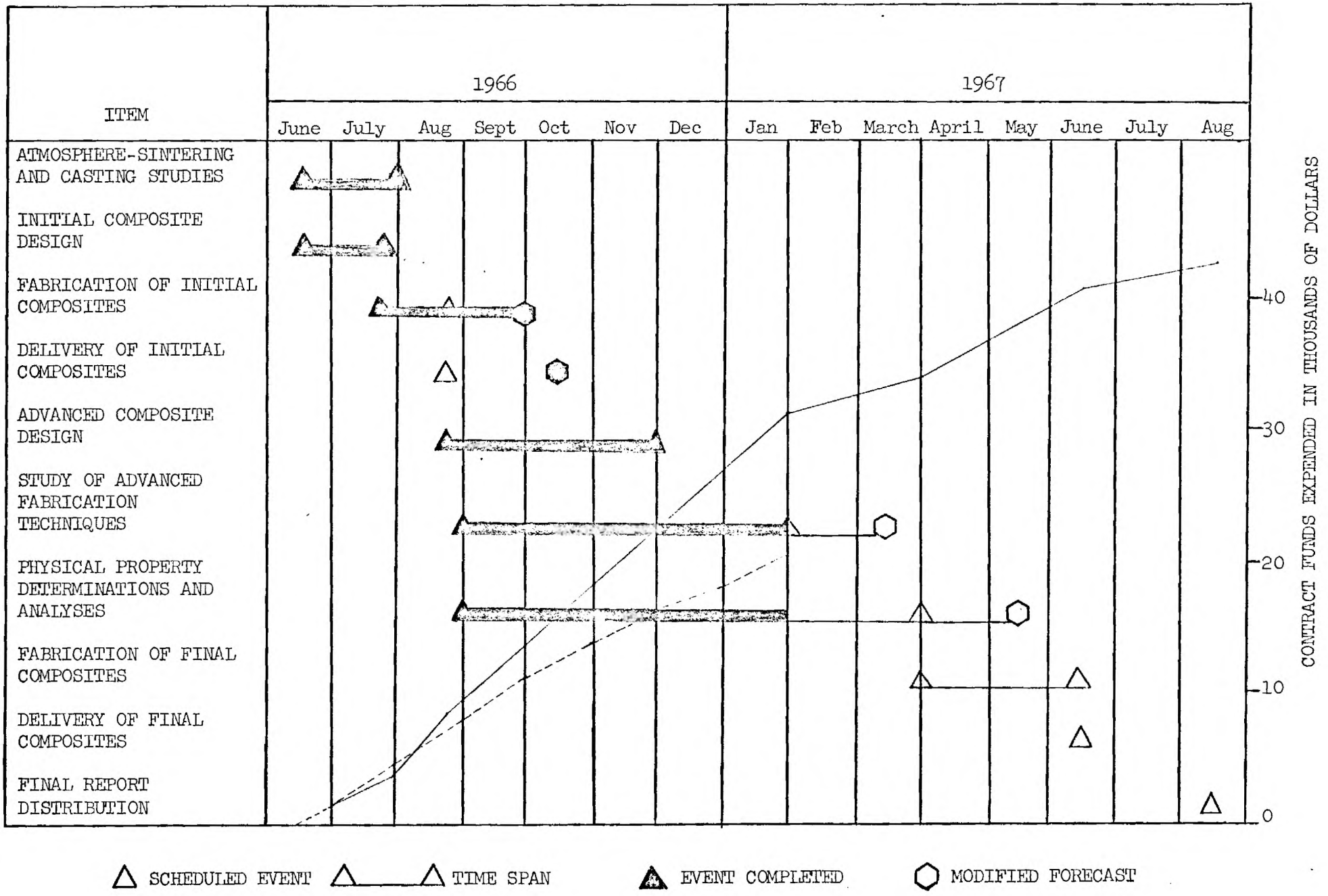
J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw

MILESTONE/COST ACCOMPLISHMENT CHART

CONTRACTOR'S NAME Georgia Tech Research Institute

Contract DA-01-021-AMC-15260(Z)



GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

March 13, 1967

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 8, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-201-AMC-15260(Z)
Covering the Period from 15 January to 15 February 1967

Gentlemen:

Specimens of Composite D having an improved microstructure were transmitted during this report period. The microstructural examination indicated that the efforts to improve the structure were successful.

The physical properties study of the various composites is presently concerned with the amount and nature of porosity. As anticipated, the porosities of the various composites are varying significantly with the specific composition. Consideration is still being given to methods of controlling the degree of porosity.

Respectfully submitted,

William J. Corbett
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw
Encl.

MILESTONE/COST ACCOMPLISHMENT CHART

CONTRACTOR'S NAME Georgia Tech Research Institute

Contract DA-01-021-AMC-15260(Z)

——— Projected Expenditure

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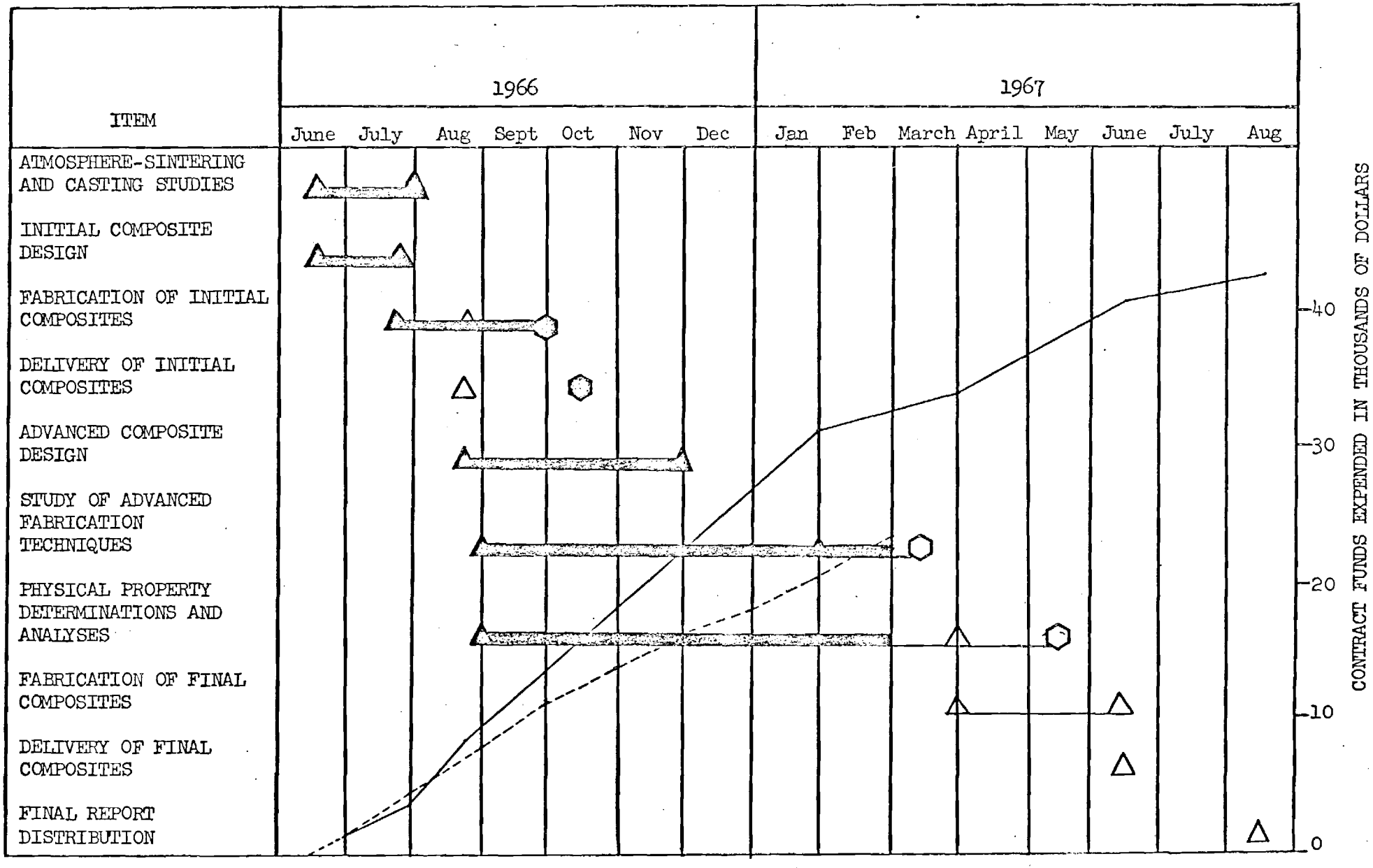

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GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

April 17, 1967

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 9, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 February to 15 March 1967

Gentlemen:

The studies of the physical properties of the various composite systems are continuing. The effect of improving the degree of dispersion of the various additives on the porosities of the composites is being investigated. The effect of additive concentration on the dynamic elastic moduli of the composites is also being investigated.

An effort toward designing an advanced composite with improved dielectric properties has begun.

Respectfully submitted,

W. J. Corbett
Project Director

Approved:

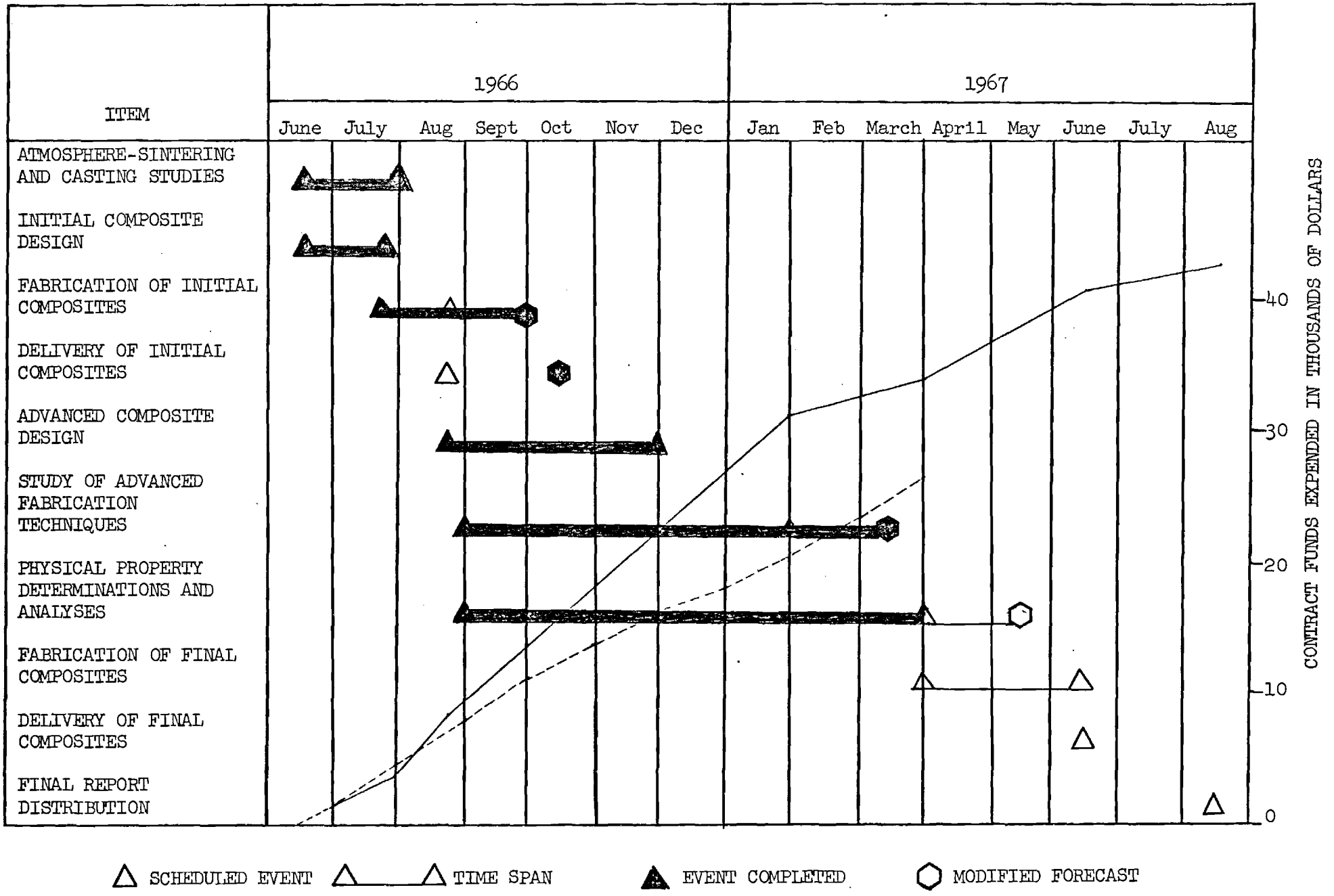
J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw

MILESTONE/COST ACCOMPLISHMENT CHART

CONTRACTOR'S NAME Georgia Tech Research Institute

Contract DA-01-021-AMC-15260(Z)



GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

May 11, 1967

Headquarters
U.S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 10, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 March to 15 April 1967

Gentlemen:

The effort on this project during the past month has been devoted to advanced composite design. The design considerations have been both mechanical response and electromagnetic transmission.

A formal request for extension of time without additional funds has been initiated for this project. This was deemed necessary to allow sufficient time to complete the evaluation phase. When notification of acceptance has been received, a revised Milestone/Cost Accomplishment Chart will be incorporated into the next letter report. To allow for this increase in performance time, the monthly rate of effort may be reduced somewhat from that originally planned.

Respectfully submitted,

William J. Corbett
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw

MILESTONE/COST ACCOMPLISHMENT CHART

CONTRACTOR'S NAME Georgia Tech Research Institute

Contract DA-01-021-AMC-15260(Z)

——— Projected Expenditure

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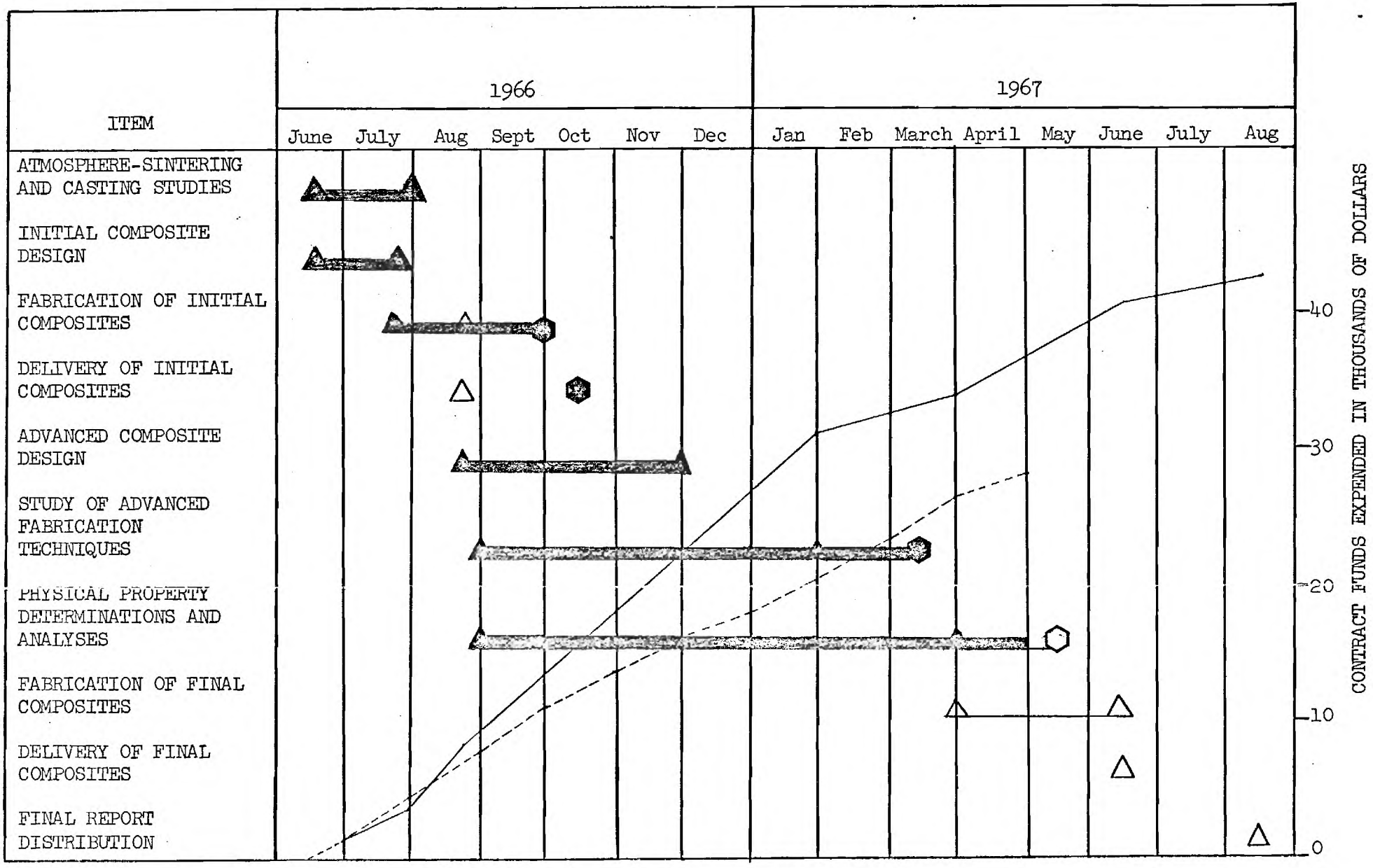

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GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

June 14, 1967

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Report 11, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC 15260(Z)
Covering the Period from 15 April to 15 May 1967

Gentlemen:

Due to the necessity of extending the performance time on this project, without additional funds, the rate of effort has been decreased. The effort on the project is presently directed toward preparing test specimens of selected composite compositions for measurement of dielectric properties. It is presently anticipated that the fabrication of these specimens will be completed during the next report period. The dielectric properties measurements will begin immediately thereafter.

The rate of effort on this project will be increased as soon as the specimens submitted to the sponsor for testing have been returned. This effort will, of course, be of an evaluation nature.

Respectfully submitted,

William J. Corbett
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/jw

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

July 19, 1967

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Reports 12 and 13, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 May to 15 July 1967

Gentlemen:

During this report period test specimens of Composite D have been prepared for dielectric properties measurements. These measurements are now being conducted in the Electronics Division of the Engineering Experiment Station.

It is expected that the composite specimens submitted to the U. S. Army Missile Command for environmental testing will be received during the next report period. The composites will then be evaluated for suitability of design.

Respectfully submitted,

William J. Corbett
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

WJC/js

ENGINEERING EXPERIMENT STATION 225 North Avenue, Northwest · Atlanta, Georgia 30332

October 17, 1967

Headquarters
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

Attention: AMSMI-IWC

Subject: Monthly Status Reports 14 and 15, Project A-947
"A Multifunctional Protection System for Re-entry Vehicles"
Contract No. DA-01-021-AMC-15260(Z)
Covering the Period from 15 July to 15 September 1967

Gentlemen:

During this report period the composite specimens submitted to the U. S. Army Missile Command for environmental testing were returned to Georgia Tech for evaluation. Qualitative evaluation in terms of performance at the several test locations has been completed. Macrophotographs of the tested samples are being prepared for comparison with similar pictures made before testing.

The new project director attended a Project Officers' Meeting at Kirtland Air Force Base on 8-9 August 1967. In order to seek additional information on the test environment and enhance the value of the final technical report, it is anticipated that he will make another visit to Kirtland in the near future. Sufficient funds for the trip are available under the present contract.

Experimental effort has been completed and the final technical report on this contract is in preparation.

Respectfully submitted,

Steve H. Bomar, Jr.
Project Director

Approved:

J. D. Walton, Jr., Head
High Temperature Materials Branch

SHB/jw